



# **Wisconsin Height Modernization Program**

**“Improving the Vertical Component of the  
Geodetic Network”**

**Wisconsin Department of Transportation  
Surveying and Mapping Section  
Geodetic Surveys Unit**

# Wisconsin Height Modernization Program

- **General HM Information**
- **WI-HMP - Processes, Status, etc.**
- **Benefit examples**
- **Overall Goals**
- **Future**

# **What is Height Modernization?**

**A nation wide program designed to improve the accuracy of the vertical component of the National Spatial Reference System (NSRS)**

- Federal Programs**
- State Programs (Wisconsin Height Modernization Program)**
- County and Local Programs**

# Why is HM needed?

## Applications that need improved heights include...

- **Construction**

- Planning and construction of buildings in or near flood-prone areas

- **Transportation**

- Design, construction, and maintenance of highways and high-speed rail systems.
- Safer low visibility aircraft landings
- Safe under-keel and overhead clearance for ships

- **Environment**

- Point and non-point pollution sources
- Efficient fertilizer and pesticide applications

# Wisconsin Height Modernization Program

- **Started by WIDT in 1998 to improve the vertical component of Geodetic Control in Wisconsin**
  - Geodetic Surveying defines exact positions on the surface of the earth versus Land Surveying that defines boundaries or areas of land
- **Partners with the National Geodetic Survey (NGS)**
  - Developed HM standards to guide HM for data inclusion in the National Spatial Reference System (NSRS)
  - Provide training and technical assistance to WIDT staff
  - Support R & D activities funded by Congress
  - Support Outreach activities in other states and regions

# Wisconsin Height Modernization Program

- Eliminates inconsistencies between horizontal and vertical control data
- Supplements control where marks have been destroyed or are deemed unusable
- Utilizes GPS technologies as a cost effective positioning tool

# Funding Sources

- **State**
  - State Transportation Funds
  - Federal Highway Administration Research Funds
- **National Oceanic and Atmospheric Administration (NOAA)**
  - Federal Congressional earmark funds

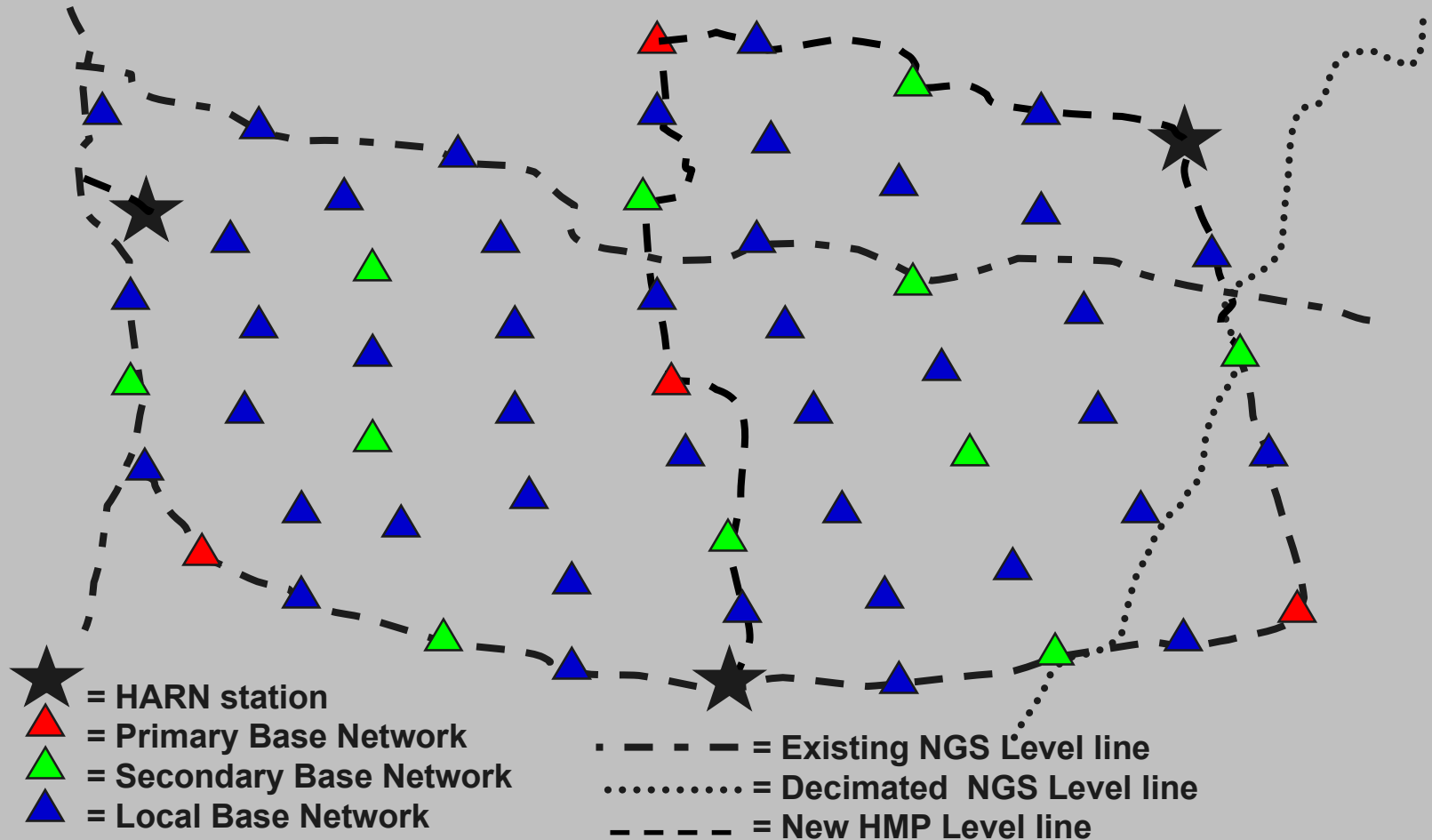
# Procedures for WI – HMP

- **4 steps are necessary to complete each area (Phase) for WI-HMP**
  - **Planning and Reconnaissance**
  - **Monumentation**
  - **Surveying**
  - **Reduction, Adjustment, and Publication of data**

# Planning and Reconnaissance

- **State is divided into geographic regions (Phases) (approximately 9,000 sq. mi. each)**
- **Search the NSRS for information on existing horizontal and vertical control**
- **Recover and evaluate all existing monumentation (published and non-published)**
- **Plan locations for supplement monumentation where deficiencies exist**
- **Hold Outreach Meetings with local officials to discuss plans and modify when necessary**

# Height Modernization Layout



# Monumentation

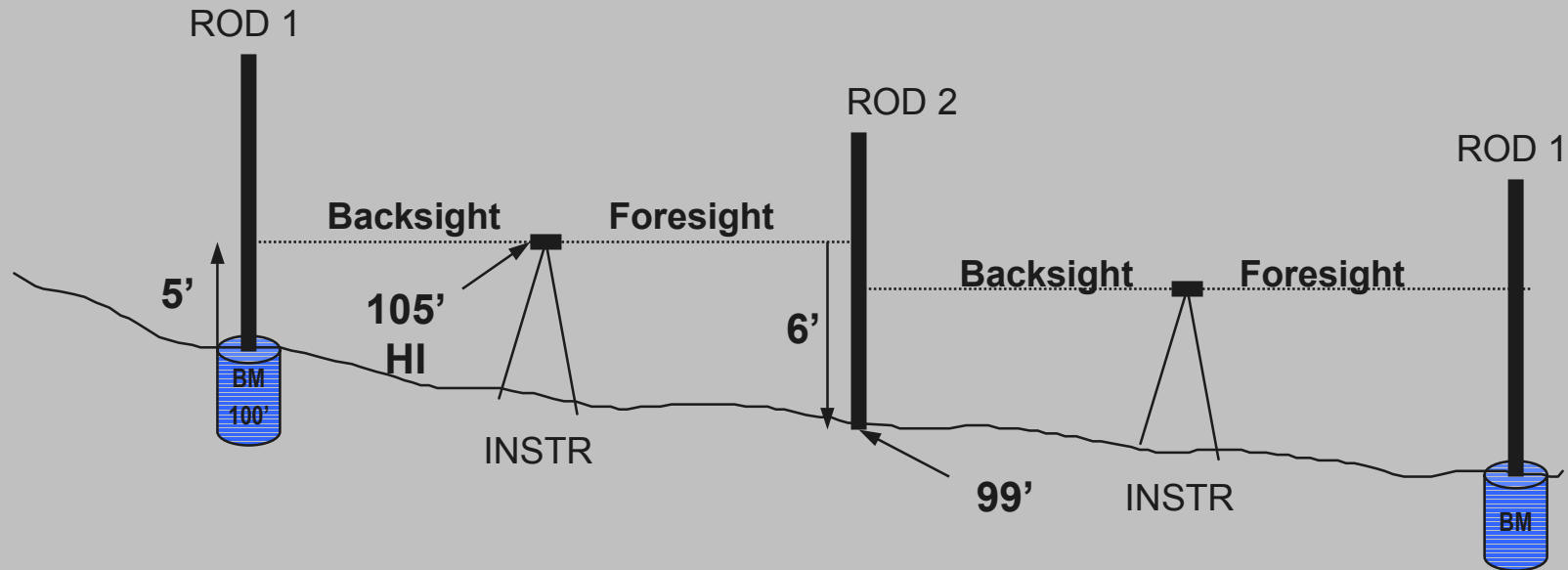
- Performed in the Summer/Fall of year prior to the year of the survey
- New monuments are 16-inch diameter, 8-foot deep pour-in- place concrete posts or disks set in stable structures
- Private sector firms have been used to construct monuments
- Monuments are described in accordance with the Federal Geodetic Control Subcommittee (FGCS) “Blue Book” standards

**Used to locate monuments, not replace them!**

# **Geodetic Surveying for WI-HMP**

- **Geodetic (Conventional) Leveling**
- **Primary Global Positioning System (GPS) Survey Campaign**
- **Secondary and Local GPS Survey Campaign**

# Conventional Leveling



# HM Conventional Leveling

- **Follow FGCS 2<sup>nd</sup> Order – Class 1 specs**
  - **Instrument Collimation performed each day of observations**
  - **60 meters maximum sight lengths**
  - **Balance Backsight/Foresights**
  - **Double observe each section of leveling under different environmental conditions**
  - **Use turning pins and staff supports**
- **Utilization of All Terrain Vehicles (ATV's) during leveling procedures has increased production by 40%**

# **Basic Observation Guidelines: HM Primary GPS**

- **At least 3 occupations of stations on different days**
- **5 ½ hour occupations for each session, one must have a different satellite constellation**
- **3 weather (Psychrometer and Barometer) readings for each session**
- **Digital images of stations are taken for each occupation**
- **All information is recorded and submitted digitally**

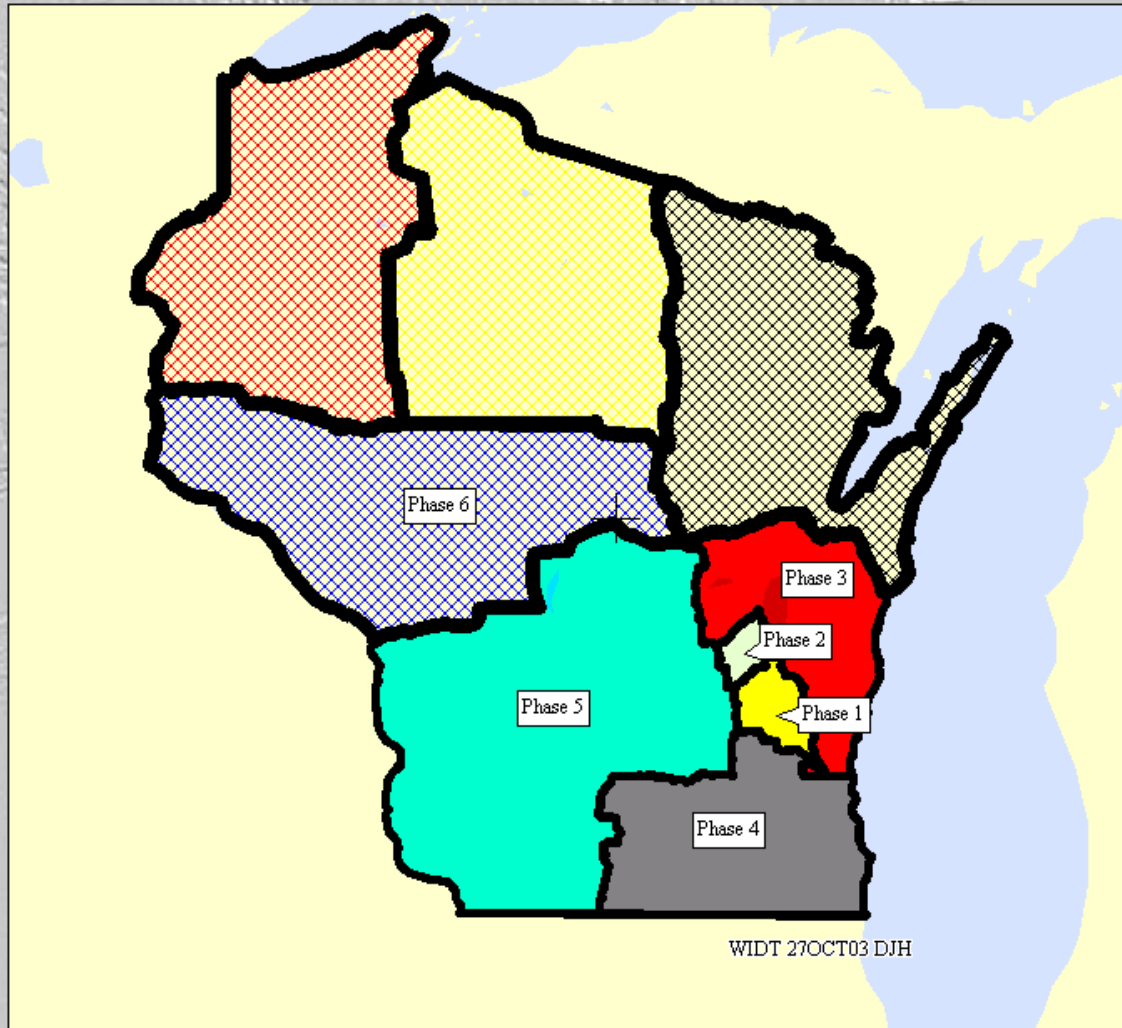
# **Basic Observation Guidelines: HM Secondary and Local GPS**

- **At least 2 occupations of stations on different days**
- **All adjacent stations must have a repeated baseline**
- **One hour occupations for each session, each must have a different satellite constellation**
- **Two weather readings for each session**
- **Digital images of stations are taken for each occupation**
- **All information is recorded and submitted digitally**

# Adjustments and Published Positions

- **Bench Marks (BM's)**  
**FGCS 2<sup>nd</sup> Order Class 1, Published on North American Vertical Datum of 1988 (NAVD 88)**
- **GPS Stations**  
**Horizontal FGCS B-order or 1<sup>st</sup> Order accuracy and GPS derived vertical 2-cm positional accuracy (not leveled). Published on North American Datum of 1983 (1997) (NAD 83 (97)) and NAVD 88**
- **All final published datasheets are available at:**  
**[www.ngs.noaa.gov/](http://www.ngs.noaa.gov/)**

# Status of Completion



# Status of Completion Phase 5 Area

- 11,500 Square Miles (22 Counties affected)
- 920 Monuments have been constructed during summer/fall 2003 by two construction firms
- Conventional leveling (2500 KM) and GPS (840 marks) observations are scheduled for 2004
- Adjustment and final results are scheduled for 2005
- **\*\*\*All schedules are dependant on funding and staffing levels\*\*\***

# Status of Completion Phase 6 Area

- 9,250 Square Miles. (16 Counties affected)
- Planning and Recon beginning Fall of 2003
- Monument construction is scheduled for 2004
- Conventional leveling and GPS observations are scheduled for 2005
- Adjustment and final results are scheduled for 2006
- **\*\*\*All schedules are dependant on funding and staffing levels\*\*\***

# **Expected Benefits and Uses of WI – HMP**

- **Navigation**
- **Agriculture**
- **Property Descriptions**
- **Land Surveying**
- **Land Information Systems**
- **Land Conservation**
- **Land Use Planning**
- **Scientific Research and Modeling**
- **Highway Construction and Improvement**

# WI-HMP and Real Time Kinematic Surveying

- Use WIDT Guidelines for 3 dimensional results within 0.07' (95%)
- Reduces transportation project survey costs by 40 – 50 %
- Combines horizontal and vertical coordinates in a single dataset (3D on all points)
- Can re-establish positions very quickly thus reducing the need for monumented engineering control
- Coordinates are available almost instantaneously

# Example of RTK Benefit: State Agency

WIDT compared a Static GPS Survey and Conventional Leveling (before HM) verses a RTK GPS Survey (after HM) of the establishment Photogrammetric Targets for Highway improvement project

- Horizontal and Vertical (elevations) positions were all within 2 cm (.07').
- Static GPS w/Leveling = 280 (hrs)
- RTK GPS = 30 (hrs)

**WI-HMP with RTK Surveying produced the same results Nine times faster!!**

# Example of RTK Benefit: County Agency

## Digital Orthophotography Field Check Point Survey for accuracy

- A survey was needed by a County to verify 10 horizontal and vertical positions derived from the digital Orthos in one 36 square mile township
- It was estimated (from past projects) to take 24 hours to perform these checks using conventional (Static GPS, Total Station and Leveling) procedures before WI-HMP
- With WI-HMP in place, RTK GPS procedures were utilized to perform these checks in just 4 hours

**WI-HMP with RTK Surveying provided 6:1  
time savings**

# Recap of Goals of WI-HMP

- **Decrease the cost of surveying required for transportation related project**
- **Improve the quality of surveys by increasing the accuracy of the geodetic network**
- **Provide a much more accurate vertical database to a wide variety of data users throughout the state**
- **Complete initial efforts by 2009**

# **Future of WI-HMP**

- **Continue to investigate opportunities to modify procedures and processes to improve efficiencies**
- **Investigate opportunities to supplement shortages of WIDT staff**
- **Provide outreach training and support to Wisconsin and surrounding states**
- **Research new technology to enhance HM efforts**
- **Continue efforts to maintain and increase funding**

# Maintenance

- **Established “866” number to report endangered, damaged, or destroyed monuments**
- **Preservation of Geodetic Survey Monuments Committee**
- **Continue to garner local support**



# Questions?

**Al Oleinik**

**Rudy  
Hernandez**

# Leveling with ATV's

- Defined by Wis. Stat. 340.01 (2G).
  - ..an engine-driven device which has a net weight of 900 pounds or less, which has a width of 48 inches or less, which is equipped with a seat designed to be straddled by the operator and which is designed to travel on 3 or more low-pressure tires.
- Authorized for use along highways by Wis. Stat. 23.33 (4) (c) 1m. - Land Surveyors Exception.

# Leveling with ATV's

- Increases production up to 40 %.
  - Average daily walking production = 0.7 mi/hr
  - Average ATV production = 1.0 mi/hr
- Reduces physical strain on crew members.
- Allows crews to have resources readily available (e.g., food, water, first aid kit, weather gear, etc.).
- Makes crews more visible.